Appendix G
Resource Adequacy

Definitions of Resource Adequacy

Resource adequacy is the ability of a utility's reliable capacity resources (supply) to meet the customers' energy or system loads (demand) at all hours within the study period. Resource adequacy for the region is defined by the Northwest Power and Conservation Council as: "A condition in which the Region is assured that, in aggregate, utilities or other load serving entities (LSE) have acquired sufficient resources to satisfy forecasted future loads reliably." The main determining factors of resource adequacy are supply and demand.

The factors that affect demand are 1) demand growth, 2) demand characteristics, 3) demand-side management, 4) sensitivity of demand to weather (temperature), and other factors. The factor that affects supply is the availability of sufficient dispatchable capacity resources.

The key challenge for long term resource planning is that supply and demand are not predictable with much certainty. The variability in supply is of particular importance, since it is so large. Therefore, SCL must use a range of possible values for supply and demand. (See the description in footnote 6.)

As a result, at any given instance (hour) a utility is concerned with its supply being capable of meeting its demand; hence, resource adequacy ($R.A._t$) at any given hour becomes the difference between the supply (S_t) and the demand (D_t) for a utility, for each hour in a year.

$R.A._t = S_t - D_t$, for every t, where t is an element of $\{1,2,3,...,8760\}$

Given this formula, at any given hour a utility desires that $S_t \geq D_t$, and consequently $R.A._t \geq 0$. When for a specific hour $R.A._t < 0$, then the utility needs to acquire the difference from wholesale power market, where it will be exposed to the volatilities of power prices and the uncertainty about the availability of the required amount of energy in the market over the desired time period.

Since supply and demand factors (system characteristics) vary from region to region and from system to system, it is difficult to standardize resource adequacy criteria and methodologies. Therefore, different regions and utilities have adopted different standards and methodologies in order to optimally measure their resource adequacy. For example, the North American Electric Reliability Corporation (NERC) general standard for generation reliability or resource adequacy criterion is that the loss of load expectation or probability (LOLE or LOLP) equal to 0.1 day per year, or one day in every 10 years.[1]

The Northwest Power Conservation Council (NPCC) has the following standard: "Peak Hourly Needs (Capacity Standard). Capacity in this context refers to the peak hourly electricity needs of the region. The measure for this is the planning reserve margin, or the surplus sustained-peaking capacity, in units of percent. It represents the surplus generating capability above the sustained-peak period demand. In determining the planning reserve margin, the standard includes the same firm and non-firm resources used to assess the energy standard for the region. The planning reserve margin is assessed over the six highest load hours of the day for three consecutive days (sustained-peak period). This is intended to simulate a cold snap or heat wave – the periods of the year when the Northwest requires the most capacity. The planning reserve margin is computed relative to normal-weather sustained-peak load. The threshold for this measure is determined by the 5-percent LOLP analysis and should be sufficient to cover load deviations due to extreme temperatures and the loss of some generating capability."[2]

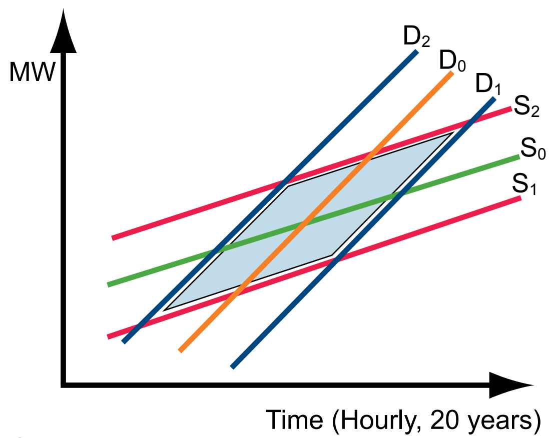
Idaho Power has adopted the following planning criterion to measure its required capacity: "Capacity – Based on monthly peak-hour Northwest transmission deficit assuming 90th percentile water, 70th percentile average load and 95th percentile peak-hour load conditions."[3]

Resoure Adequacy Analysis

With stakeholder and public input, City Light has elected to use the following resource adequacy standard for measuring its supply reliability: SCL plans its reliable capacity resources in order to be able to meet its highest hourly demand 95 percent of the time.

For this, City Light designed a probabilistic approach to perform risk analysis around expected hourly supply and demand. This analysis tests simultaneously the ability of the system to withstand sudden disturbances, such as unanticipated loss of system facilities or generation capability (supply volatility) and sudden changes in the load pattern (demand volatility). This is illustrated schematically in Figure 1. The shaded area determines the logical possible disturbances that can occur to SCL system at any given hour during the study period. Thus, City Light has developed "risk metrics" for demand and supply in order to perform this probabilistic analysis to achieve a 95 percent LOLP for the highest hourly load demand. The highest hourly load is represented by the highest load in the month of December. Risk has been evaluated for demand and supply independently.[4]

Figure 1. Risk Analysis of Supply and Demand (MW)



(Schematic, not to scale.)

Demand Risk (D_t):

Heating Demand (Extreme Low Temperatures): November through February

In order to develop accurate risk metric for demand, City Light has done a thorough statistical analysis on hourly historical demand data from1981 through 2007. Based upon these data, City Light has had annual one hour peaks in the months of November through February; however, the greatest frequency of peaks has occurred within the months of December and January. Among all the months, December had the highest one hour peak. Therefore, demand volatility for the month of December was selected for the probability distribution analysis for the purpose of simulation.

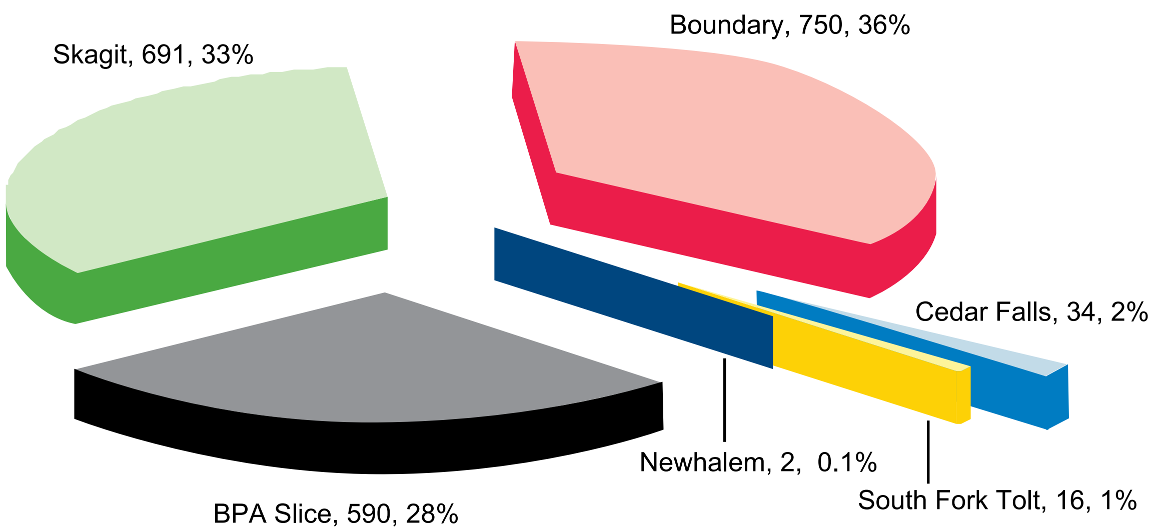
Supply Risk (S_t):

Volatilities in the Dispatchable Capacity Resources

Supply risk is uncertainty in "availability of dispatchable capacity resources"[5] for any given hour. Since City Light's resource portfolio is about 90 percent hydroelectric generation, supply risk becomes the volatility in hydro capacity resources. Hourly hydro generation is a function of stored water and forced outages. Stored water is a function of water conditions. For example, if City Light is experiencing a dry year, its capability of storing water decreases and consequently so does its generation capability. For two or three days, a hydro generation plant with stored water is less dependent upon water conditions; however, as stored water is depleted due to prolonged operations at maximum output, it becomes increasingly dependent on water conditions. Thus, City Light can generate the maximum output of its hydro capacity resources up to available capabilities for any given hour.

City Light's generation capability will decrease due to changes in the BPA Slice product resources beginning in Oct 2011 (Figure 2). In Figure 2, only dispatchable hydro capacity resources are included, since other types of electric generation, such as wind and power contracts, in City Light's resource portfolio are not dispatchable.

Figure 2. Expected One-Hour Generation Capability (MW) of Hydro Resources in December 2011



Historical data show that the highest one hour peak is most likely to occur during the months of December and January, but the highest one hour peak has occurred in December; thus, the historical hourly volatility of its hydro resources for the month of December are used in the probability distribution analysis. Hydro volatility is not equal across all hydro resources due to different geographical locations and microclimate conditions associated with these resources, as well as differences in storage capacity in the reservoirs. For example, Boundary could have dry water conditions, while at the same time, Skagit could have average water conditions. Therefore, cross sectional correlations of these resources are applied to the probability distribution analysis for the purpose of simulation.

Results

As stated in previous sections, extensive statistical analyses on historical hourly demand and supply of City Light have been done for the probability distribution analysis in order to design the risk metrics, used for calculating the adequacy of resources.[6] City Light has made further assumptions about the supply variables as follows:

- Assumptions about the continuing operation of existing resources, taking into account forced outages and scheduled maintenance; for instance, Boundary relicensing and BPA contract renewal.
- An assumption about the operating reserve requirement for City Light's resource portfolio.
- Expiration of existing contracts on schedule.
- Adjusting City Light hydro capability for extreme temperatures and shortage conditions (approximately 100 aMW).

- 100 aMW market purchase of electricity under the most extreme temperatures and shortage conditions of planning period.

The resource adequacy analysis described above defines a measure that is used to identify the amount of energy the utility may need each year during the heating season, as represented by supply and demand conditions in the month of December. The simulation together with all these considerations for the study period, 2010 through 2029, led to the estimated resource requirements in the month of December by year shown in Figure 3.

After taking into account additional hydro capability, conservation, and 100 aMW of short-term market purchases assumptions at any given hour, resource adequacy changes as shown in Figure 4.

Figure 3. Additional Resources Needed to Meet Resource Adequacy at 95%

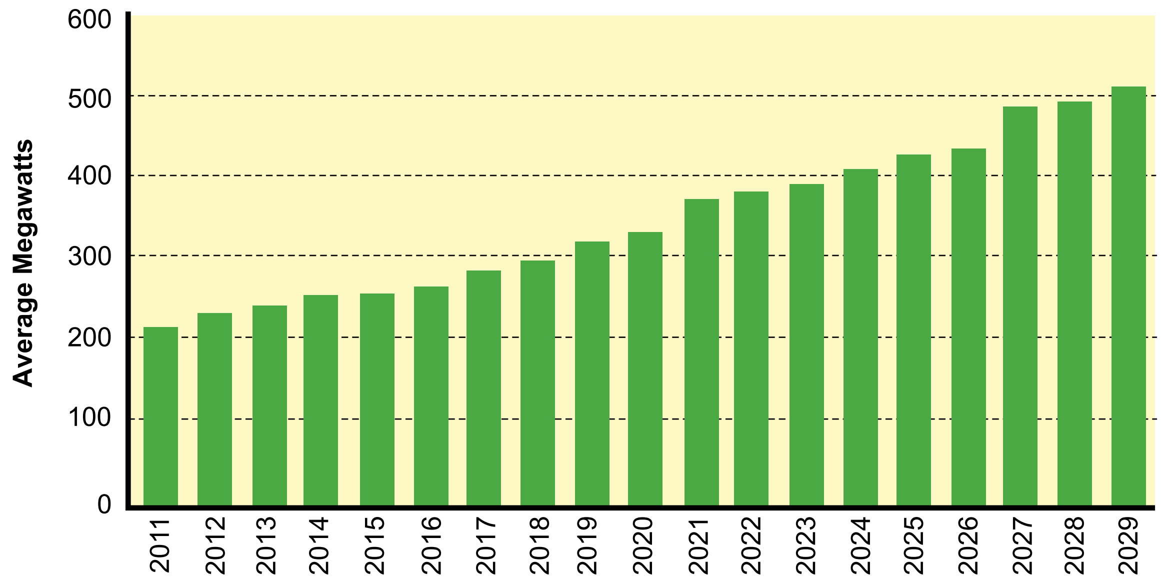
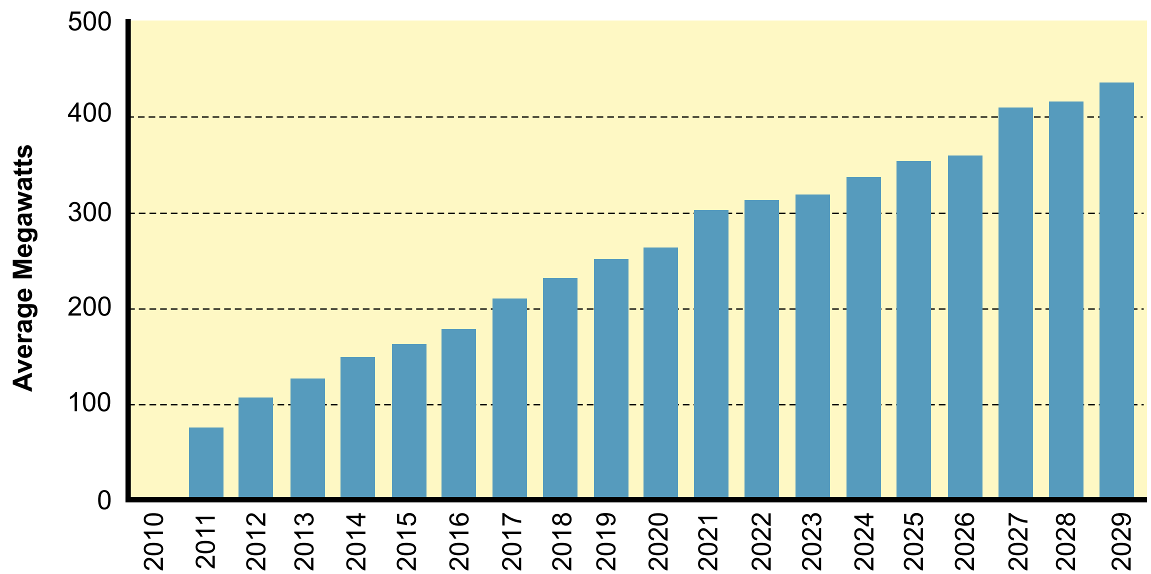


Figure 4. Resources Needed to Meet Resource Adequacy
(with adjustment for hydro capability, conservation, and market assumptions)



[1] North American Electric Reliability Corporation, Reliability Standards, June 15, 2004.

[2] Northwest Power Conservation Council, Regional Adequacy Standards for the Northwest, Chapter 14, page 7, April 16, 2008.

[3] 2009 Integrated Resource Planning, Idaho Power Company, Appendix C: Summary of Northwest Utility Planning Criteria, page 170.

[4] Risk is applied to supply and demand independently. Increases in load due to lower temperature can be met by increases in generation up to the generation's available capability Capability is defined as the generation allowed by the current water conditions, minus any forced outages and scheduled maintenance. For example, Boundary capacity is 1040 MW. Now assume that one unit is out and the available capacity is reduced to 880 MW. On average, City Light generates about 500 MW from Boundary; if demand goes up hypothetically by 400 MW then we can generate another 380 MW from Boundary (880 minus 500). To generate this amount, 800 SFD of stored water is required, which is often available at Boundary dam. Hence, actual generation can be adjusted to meet changes in demand, but the available capability does not change. Therefore, the following relationship exists:

CORR [Water (Available Capability), System Load] ≈ 0

[5] Dispatchable generation capacity refers to capacity resources, such as hydropower or a natural gas simple cycle combustion turbine that can be dispatched at the request of power grid operators, that is, turned on (or off) on demand. This should be contrasted with certain types of base load generation capacity, such as nuclear power, which may have limited dispatch capability.

[6] As stated in the main body of this document, resource adequacy is a function of supply and demand; hence, in general, the following abstract form for the function of resource adequacy holds:

$R.A._t = S_t - D_t$, for every t, where t is an element of $\{1,2,3,...,8760\}$

After developing the risk metrics for supply and demand, this general form can be restated, for City Light, as follows:

$$R.A._{t_h} = F_{t_h}(SKAGIT_{DEC_h}, BN_{DEC_h}, SLICE_{DEC_h})$$

In the above formula, note that the subscript indicates hourly time for the month of December, SKAGIT indicates Ross, Diablo and Gorge, BN indicates Boundary, and SLICE indicates 26 BPA projects from which City Light receives a fixed percentage of generation and other capabilities of the Federal Columbia River power system. Using the Aurora model, City Light has implemented Latin Hypercube simulation to measure its hourly resource adequacy; 1,300 scenarios on hourly supply and demand have been applied simultaneously for 20 years of the study period, 2010 through 2029. Figure 3 illustrates the additional resources that are needed to meet 95% of the occurrences of the maximum LOLP of hourly peaks for the month of December, and consequently the 5% chance of exceedance.